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Individual characterization of Iberian pig through NIRS technology: Implementation in Sierra de Sevilla, S.A.

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Abstract. The Iberian pig industry has established several quality control programs in order to determine and guarantee the pig feeding system, especially in the last period of growing. These programs consisted of on-farm Iberian pig inspection or fatty acids composition of subcutaneous tissue fat. The potential of NIRS technology in the classification of Iberian pig carcasses in the several commercial categories, according to their feeding system, has been reported by researchers at the University of Cordoba in the last years. However, the implementation of this technology at industrial level has not been yet as widespread as expected in comparison with other industries such as animal feed industry. This communication reports the results obtained in the first year of the project for the implementation of NIRS technology as quality control tool in the "Sierra de Sevilla" Company which elaborates meat products from Iberian pig. The use of NIRS technology as quality control tool allowed a fast, reliable and inexpensive characterization of each animal. Individual characterization is of great importance in "recebo" batches, where a large variability between animals was found. The good results obtained to date have given individual information of its animals to the Company providing a better quality control of their products and also monitoring the farm suppliers.

Keywords. Iberian pig – Agro food industry – NIRS technology – Quality control – Feeding system.

Caractérisation individuelle du porc Ibérique par la technologie NIRS : Mise en œuvre dans l'entreprise "Sierra de Sevilla" S.A.

Résumé. *L'industrie du porc ibérique a établi des programmes de contrôle de qualité pour déterminer et veiller sur le système d'alimentation des porcs, en particulier dans la dernière période de croissance. Ces programmes comprennent l'inspection des animaux sur le terrain et l'analyse de la composition en acides gras des tissus adipeux sous-cutanés. Des années de recherche à l'Université de Cordoba ont montré le potentiel de la technologie NIRS pour la classification des carcasses de porc Ibérique en catégories commerciales, en fonction de leur système d'alimentation. Toutefois, en comparaison avec d'autres industries (par exemple, celle des aliments pour animaux), la mise en œuvre de cette technologie au niveau industriel pour le secteur du porc Ibérique est encore très limitée. Cette communication présente les résultats obtenus dans la première année du projet pour la mise en œuvre de la technologie NIRS comme outil de contrôle qualité dans l'entreprise de produits à base de viande provenant de porcs Ibériques «Sierra de Sevilla». L'utilisation de la technologie NIRS comme outil de contrôle de qualité a permis une caractérisation rapide, fiable et peu coûteuse de chaque animal. La caractérisation individuelle est d'une importance cruciale dans les groupes du «recebo», où une grande variabilité entre les animaux appartenant au même groupe a été trouvée. Les bons résultats obtenus à ce jour ont donné des informations individuelles sur les animaux de l'entreprise, en permettant un meilleur contrôle de la qualité de leurs produits et aussi un meilleur suivi des élevages fournisseurs.*

Mots-clés. *Porc Ibérique – Industrie alimentaire – Technologie NIRS – Contrôle de la qualité – Système d'alimentation.*

I – Introduction

Iberian pig ham is one of the most expensive food products produced in Spain. Three commercial categories ("*Bellota* or Acorn", "*Recebo* or Acorn+compound feed" and "*Cebo* or compound feed") are established, according to the pig feeding system, especially during the final phase of the growing period. The classification of these expensive products is of huge interest for industries, authorities and consumers and, for this reason, great efforts have been performed to obtain efficient and reliable methods that allowed a right and unequivocal classification (De Pedro, 2001). In the last years, different methods were applied on the basis of the fatty acid profile in subcutaneous fat or on-farm inspections to classify pig batches in commercial categories (Garrido-Varo and De Pedro, 2007); however these methods provided global information of each batch but individual information of each pig is missing. On the other hand, consumers would have as much nutritional information as possible of these expensive food products and Iberian pig industry has to meet consumer's requirements in order to guarantee the quality of these products and thus satisfy the consumer requests.

The results obtained in the first year of the implementation of NIRS technology as quality control tool in "Sierra de Sevilla" Company allowed a fast, inexpensive and reliable characterization of each pig according to their fatty acid profile. As a result, "Sierra de Sevilla" could improve the maturation process of each piece as well as the quality assurance and traceability of each one of its food products.

II – Materials and methods

A set of 250 Iberian pig subcutaneous fat samples, from 17 batches with different pig feeding system, were analysed by NIRS in Sierra de Sevilla (Sevilla, Spain) and official gas chromatography data were obtained from a certified laboratory.

NIR absorbance spectra were collected in reflectance mode (log (1/R)) using a FOSS-NIRSystems 5000 spectrometer equipped with a remote reflectance probe (FOSS, Hillerød, Denmark), in the wavelength region between 1100 and 2500 nm (every 2 nm). Each subcutaneous fat sample was taken from carcass of Iberian pigs in the sacrifice line, from the tail insertion area in the coxal region, the same area as that used by the Designation of Origin committees (ref). Subcutaneous fat samples were stored at –20 ºC until analyses were performed. NIRS analysis was carried out by placing directly the thawed subcutaneous fat sample on the probe and spectra were collected and recorded using ISIscan™ Routine Analysis Software 3.5 version (Infrasoft International, Port Matilda, PA, USA).

Once the NIRS analysis was performed, adipose tissue sample was heated by microwave energy to melt the fat (De Pedro *et al.,* 1997). After removing the supernatant subcutaneous tissue, the appropriate liquid sample amount was taken to be sent to the laboratory, where the fatty acid composition was determined by gas chromatography, in accordance with the official method, to get the reference data.

NIR and reference data were used to develop modified partial least squares (MPLS) calibration equations by using WINISI software version 1.50 (FOSS NIRSystems Inc., Laurel, MD, USA) to predict fatty acid profile of the fat tissue samples (Williams & Sobering, 1996).

III – Results and discussion

As animal with different feeding systems had been selected, individual reference data of the 250 samples showed a great variability, (i.e. oleic acid ranged 48 to 58%), and so enough variability has been included in the calibration model to provide reliable predicted NIRS data in all categories.

Table 1 and Table 2 show individual fatty acid profile (4 major fatty acids) of 12 Iberian pigs from a batch of 130 animals fed with grass and acorns (*bellota*) and another 12 Iberian pigs from a batch of 120 animals fed with grass, acorns and supplemented with compound feed (*recebo*), respectively.

Table 1. Gas chromatography and NIRS predicted data of the 4 major fatty acids in a *bellota* batch

	Palmitic acid (C16:0)		Stearic acid (C18:0)		Oleic acid (C18:1)		Linooleic acid (C18:2)	
Sample	**LAB**	**NIR**	**LAB**	**NIR**	**LAB**	**NIR**	**LAB**	**NIR**
1	21.5	21.4	9.2	9.7	54.9	54.2	8.6	8.5
2	20.5	20.7	9.0	9.3	55.9	55.3	8.9	8.8
3	19.6	19.9	9.7	9.4	56.1	56.2	9.9	8.8
4	19.9	19.7	8.3	8.5	56.6	56.3	9.2	9.2
5	19.3	19.5	8.7	9.2	57.1	56.4	9.5	9.2
6	19.2	19.9	8.3	8.5	57.5	56.8	9.2	9.3
7	18.7	19.4	8.3	9.5	57.7	57.5	9.8	9.1
8	19.1	19.6	8.3	8.1	57.9	57.3	9.2	8.9
9	19.0	19.7	7.6	8.0	57.9	56.6	9.6	9.7
10	19.0	18.9	8.7	8.2	57.9	57.6	8.9	9.2
11	18.8	18.9	7.7	7.9	58.3	57.9	9.6	9.5
12	19.2	19.4	8.4	8.0	58.5	58.3	8.4	8.8
…	…	…	…	…	…	…	…	…
Lab/NIR average (n=12)	19.5	19.8	8.5	8.7	57.2	56.7	9.2	9.1
Lab/NIR Variance (n=12)	0.7	0.5	0.4	0.4	1.1	1.2	0.1	0.1
Batch average (n=130)	19.3		8.1		56.8		98	

As can be seen in both Tables, slight differences between official gas chromatography method and NIRS predicted values were found in all samples (12 Iberian pig of each batch) as well as in average values, indicating the good prediction ability of the calibration model. The batch average value, usually employed in the Iberian pig industry to classify Iberian pigs and select the best maturation process of pieces (hams, shoulders and sausages) is also indicated at the bottom of the table.

Individual *versus* batch average analysis of Iberian pig subcutaneous tissue samples allowed detecting differences in the fatty acid profile of animals from a same batch, being these differences more marked in the *recebo* batches than in *bellota* ones. So, oleic and stearic acid values from 50.3 to 57.8 and 8.3 to 11.7, respectively, were found in the *recebo* batch (see Table 2) whereas in the *bellota* batch (see Table 1) these fatty acids only varied from 54.8 to 58.5 and from 7.6 to 9.7, respectively. In general, the magnitude of these differences between animals from a same batch of *bellota* or *recebo* could be observed by using statistical parameters to compare sample sets such as coefficient of variation, standard deviation or variance, among others.

Tables 1 and 2 show variance values found for each fatty acid in *bellota* and *recebo* batches, respectively. In all cases, variance values are higher in *recebo* than in *bellota*, owing to the greatest variability between animals from *recebo* batch.

Table 2. Gas chromatography and NIRS predicted data of the 4 major fatty acids in a recebo batch.

	Palmitic acid (C16:0)		Stearic acid (C18:0)		Oleic acid (C18:1)		Linooleic acid (C18:2)	
Sample	**LAB**	**NIR**	**LAB**	**NIR**	**LAB**	**NIR**	**LAB**	**NIR**
1	22.9	22.7	12.0	11.7	50.4	50.3	9.0	8.7
2	21.5	21.8	9.9	10.5	52.9	53.8	9.8	9.1
3	21.5	21.3	10.3	10.5	53.4	53.8	8.9	8.6
4	21.5	21.2	9.9	9.7	53.6	54.8	8.7	8.7
5	21.3	21.3	10.7	10.7	53.7	53.1	8.4	8.4
6	20.0	20.1	9.4	9.0	55.0	55.2	9.7	9.3
7	19.2	20.1	10.7	10.1	55.8	55.5	8.6	8.9
8	18.8	19.6	9.6	8.9	56.5	56.1	9.3	9.2
9	19.0	19.4	8.6	8.4	57.0	57.2	9.1	9.0
10	18.9	19.5	8.3	8.2	57.1	57.2	9.4	9.4
11	17.6	17.8	9.8	9.1	57.8	57.4	9.2	9.8
12	18.8	18.3	9.5	9.2	57.2	57.3	9.3	9.6
…	…	…	…	…	…	…	…	…
Lab/NIR average (r=12)	20.1	20.3	9.9	9.7	55.0	55.1	9.1	9.1
Lab/NIR variance (r=12)	1.4	1.2	0.6	0.6	2.2	2.0	0.2	0.2
Batch average (n=120)	19.4		9.4		55.2		9.8	

Taking into account that Iberian pig industries use the 4 major fatty acid values of the batch as quality control parameter for all the animals included in this batch, the implementation of NIRS technology in Sierra de Sevilla, S.A. for the individual characterization of each animal implies a step forward in the quality assurance and traceability of their food products.

IV – Conclusions

(i) NIRS technology allows a fast, inexpensive and reliable characterization of each pig according to their fatty acid profile of the subcutaneous tissue, providing similar results as the official gas chromatography method.

(ii) Individual *versus* batch average analysis could detect differences between animals included in the same batch, being these differences more marked in the *recebo* batch.

(iii) The implementation of NIRS technology in Sierra de Sevilla S.A. enables individual quality control in their production process monitoring each animal at the reception zone and giving useful information for their optimal maturation process.

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